

Human Factors Principles Applied to CAD/CAM

Presentation by Eric N. Wiebe
NC State University

Forsythe, C., Karwowski, W., Wiebe, E. N., Baba, M., Ashby, R., Lahlou, S. (October, 1995). Human Factors in Agile Manufacturing. Panel session presentation at the Human Factors and Ergonomics Society 39th Annual Meeting, San Diego, CA.

Abstract

CAD/CAM technology has advanced rapidly in the last few years but only recently have vendors begun to pay serious attention to their integration into an open systems, enterprise-wide product database. A concurrent, collaborative organizational environment is an integral part of agile manufacturing. A common product database, in turn, is critical to effective communication in such an environment. The geometric model generated by CAD tools has been underutilized as a means of increasing the efficiency of communications during product development and manufacture by providing a means of organizing and graphically representing design and engineering intent. Human factors principles of visual performance applied to the 3-D graphic capabilities of current CAD/CAM systems can dramatically increase the bandwidth of communications in a computer-mediated collaborative environment. In addition, the 3-D CAD model can act as an interface to a product database of non-geometric information used throughout the product life cycle.

Agile Manufacturing Goals

- Address organization, people, and technology on equal footing
- Enhance rather than replace human capabilities
- Rapid, flexible response to customer

Role of Computer-aided Design Tools

- CAD as computer-*aided* design not computer-*automated* design
- Historically used as means of automating drafting tasks
- Need to tap perceptual and cognitive strengths of users
- Use CAD as a collaborative tool
 - Part of an enterprise-wide database
 - Enhance both asynchronous and synchronous group design work

Traditional Use of CAD in the Design Process

- Used to produce static 2-D documents
 - Documentation for manufacturing
 - Occurred late in the design process
- Not usually a collaboratively produced document
- Need special skills to interpret multiview drawing
 - Specialized notation and symbols
 - Heavy cognitive load
 - Often did not take advantage of perceptual capabilities

Evolving CAD Applications

- Development of 3-D model
- Can be used to automate drawing production
- Tremendous potential as virtual product model
- Need to link model representation to model use
 - Going beyond just representing geometry in model
 - Linking textual and numeric information to geometry
- Further understanding of tasks
 - Individual design work
 - Group work

Example Areas of Exploration

- Use of modeling early in the design process
 - Appropriate modes of representation for engineer/designer collaboration
 - Interactive tools for exploration of design alternatives
- Display of analytic data
 - Application of scientific visualization techniques
 - Use of rendering and animation for the display of quantitative data
 - Integration of analytic data with the geometric model
- Creation of manufacturing scenarios
 - virtual models for simulating the fabrication and assembly process

Product Databases in the Furniture Industry

- Parts management for casegoods and upholstery frames
- Use of off-the-shelf software to enhance the application of 3-D parametrically constrained models
- Give the product engineer a visual link to current parts in stock
 - parts organized by key geometric and functional characteristics
- Provide a timely method for mocking up alternatives during design reviews
 - collaborative tool for the engineer and designer

Recognition of Model Change

- Visual performance issues concerning the individual operator
- Factors which impact the ability to discern differences between 3-D virtual objects
 - topological
 - metric
 - task condition
 - model representation

Summary

- Role of the enterprise in implementing recommendations
 - Interdepartmental cooperation for enterprise-wide problems
 - Fast and wide networking infrastructure
- Evolving CAD standards
 - Parametrics
 - Tight integration of Product Data Management tools
 - Unrestricted geometry generation and representation
- Use of technology to achieve organizational goals